ENERGY

ABSTRACT

Energy is the grease that lubricates the U.S. economic wheel. It truly affects all our endeavors and is inextricably linked to our national security. The U.S. energy industry is robust, competitive and rapidly evolving. Recent events in California and rising prices for gasoline and natural gas have rocketed this industry into the public's spotlight and discussion. Secretary Abraham in a recent speech to the U.S. Chamber of Commerce stated, "The country is in the midst of an energy crisis with no short term solutions." Unlike previous energy crises, this most recent one has been largely self-generated by our inattention to trends, lack of leadership and mismanagement. Our assessment is that there are no shortages of energy supplies, just a lack of ability to deliver them efficiently to the consumer. Our challenge as a nation will be to develop and manage those energy resources in a way that achieves an acceptable balance between the often-competing demands of environmental protection and economic growth. This report addresses the current status and future prospects of the energy industry in meeting the country's future energy demands.

BGEN Gordon Cacic, Army, Croatia

Lt Col Stephen "Scotty" Fairbairn, USAF

Mr. Alonzo Fulgham, U.S. Agency for International Development

Mr. Mark Kammer, Dept. of the Air Force

LTC Tony Kazmierski, USA

LTC Howard "Dave" Laine, USA

Mr. James Moreland, Dept. of the Navy

Ms. Valerie Pietro, Defense Intelligence Agency

Lt Col Michael "HiHo" Silver, USAF

LTC Richard Smart, USA

CDR John Stewart, USN

Lt Col Phil Swanson, USAF

CAPT James Watson, U.S. Coast Guard

Lt Col Greg Williams, USAF

Dr. Maureen Crandall, Faculty

Col Lee McMillen, USA, Faculty

Mr. Steve Buck, Faculty

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2001		**00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Energy	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **National Defense University,The Industrial College of the Armed Forces,Washington,DC,20319**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**21**	

PLACES VISITED

Domestic

BP Solar, Fairfield, CA
CONSOL Energy, Enlow Fork Mine, Washington, PA
California Independent System Operator, San Francisco, CA
California Public Utilities Commission, San Francisco, CA
Capstone Turbine Corporation, Chatsworth, CA
Chevron Corporation, San Francisco, CA
Chevron Richmond Refinery, Richmond, CA
Enron Corporation, San Francisco, CA
ExxonMobil Corporation, Harmony Platform, Santa Barbara, CA
ExxonMobil Corporation, Las Flores Canyon, Santa Barbara, CA
Mirant Corporation, Dickerson, MD
National Mining Association, Morgantown, WV
National Resources Defense Council, San Francisco, CA
New York Mercantile Exchange, New York, NY
Ogden Martin Systems of Montgomery, Inc., Dickerson, MD
Pacific Gas and Electric Company, San Francisco, CA

International

Abu Dhabi National Oil Company, Abu Dhabi, United Arab Emirates
Abu Dhabi Water and Electricity Authority, Abu Dhabi, United Arab Emirates
American Business Council of Dubai and the Northern Emirates, Dubai, United Arab Emirates
BP International Ltd., Abu Dhabi, United Arab Emirates
Caltex Corporation, Dubai, United Arab Emirates
Defense Energy Supply Center, Fujairah, United Arab Emirates
Electricité de France, Penly Nuclear Power Plant, Penly, France
Emirates Center for Strategic Studies and Research, Abu Dhabi, United Arab Emirates
Enron Middle East, Dubai, United Arab Emirates
ExxonMobil, Abu Dhabi, United Arab Emirates
International Energy Agency, Paris, France
TotalFinaElf, Paris, France
UAE Offsets Group, Abu Dhabi, United Arab Emirates
U.S. Embassy, Abu Dhabi, United Arab Emirates

INTRODUCTION

Caveman society derived comfort, security and productivity from fire. Today's "fire" delivered to us in the form of electricity and combustion of natural gas, coal and oil continues to satisfy those same basic needs. Throughout history, energy use has continually increased, enabling the growth of populations and living standards. The industrial revolution began with James Watt's invention of an energy-conversion technology -- the steam engine -- and its hallmark has been the continued invention and application of increasingly sophisticated energy-conversion and end-use technologies that increase economic productivity and lead to higher standards of living.

Energy is fundamental to the functioning and prosperity of industrial societies. It lights cities; heats and cools factories, homes and offices; powers computers; fuels trucks, trains and automobiles; fires blast furnaces; and heats food in ovens or cools it in refrigerators. The availability of energy and the ever-changing technologies to convert it into usable forms have also been critical to U.S. and world economic growth. Energy is a part of the cost of goods sold in every corporate report. Energy is the grease that lubricates the U.S. economic wheel.

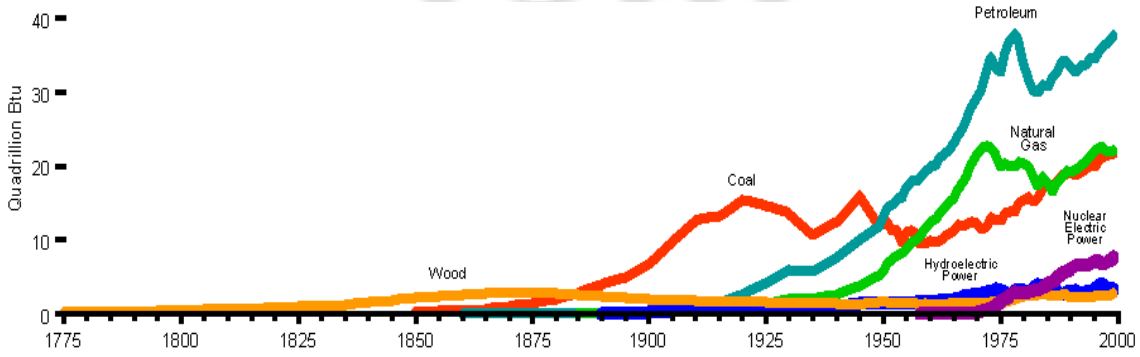
Today, the U.S. is the leading world consumer of all types of energy and is at the forefront of world technological developments in finding and converting energy. While there are many primary sources of energy, this report will focus on those forms that are predominant in our society today: fossil fuels (coal, oil and natural gas), nuclear and renewable sources (such as hydro, solar, wind, geothermal and biomass).

THE UNITED STATES ENERGY INDUSTRY DEFINED

Production and Consumption

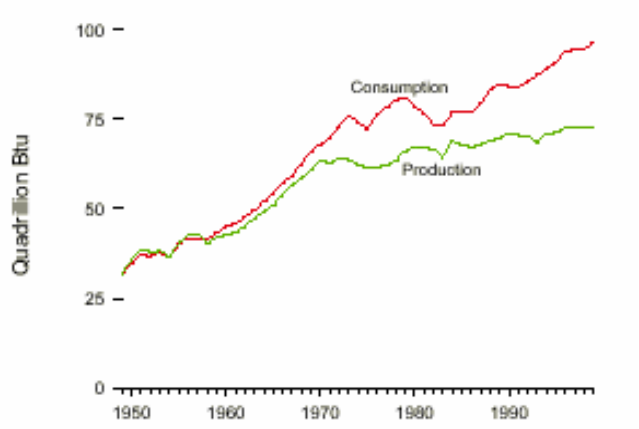
Although energy production draws from many sources (see figure below), most energy produced today in the U. S. and elsewhere comes from fossil fuels - coal, natural gas, and petroleum. In 1999, fossil fuels accounted for 80% of U.S. energy production and were valued at over $90 billion.[1] Americans consume 25% of the world's energy even though they are only 5% of the world's population.[2] Energy comprises about 7% of the U.S. economy,[3] but as a raw material in almost every good or service, its multiplier effect is far reaching.

Source: DOE/EIA

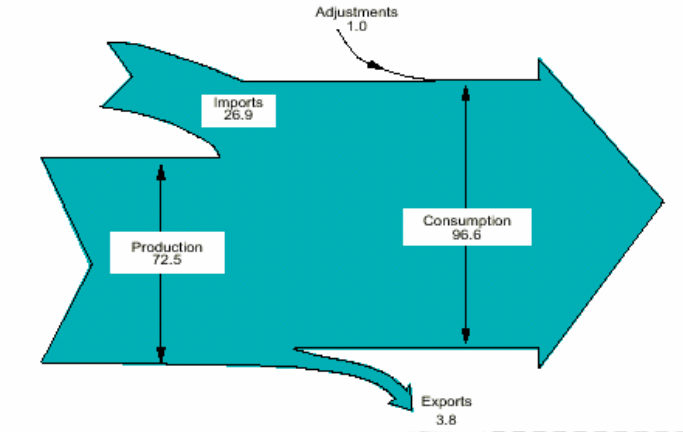


Energy Consumption in the United States, 1775-1999

For much of its history, the U.S. has been mostly self-sufficient in energy. Through the late 1950s, production and consumption were nearly in balance. In the 1960s, however, consumption began to outpace domestic production. By the early 1970s, a more significant gap had developed (see right figure).



Source: DOE/EIA



Source: DOE/EIA

In 1999, the U.S. produced approximately 73 quadrillion British thermal units (Btu) of energy and exported almost 4 quadrillion Btu. During the same period, consumption totaled 97 quadrillion Btu, requiring imports of 27 quadrillion Btu (see left figure).

Energy plays a central role in the operation of the U.S. economy. In recent years, American consumers have spent over half a trillion dollars a year on energy.[4] That energy is consumed in three broad end-use sectors: the residential and commercial sector, the industrial sector, and the transportation sector. The Energy Information Agency (EIA) is projecting an increase in energy consumption that cuts across all end-use sectors. To better understand energy production, a review of each of the major sources is presented:

- Petroleum
- Coal
- Natural Gas
- Nuclear
- Renewables

Petroleum

What do fertilizer, chewing gum, paint thinner, medicine, cosmetics and gasoline have in common? It may surprise you that all these items and hundreds more require varying amounts of petroleum. In fact, Americans consume on average nearly 3 gallons of petroleum per person per day.[5] Further, the U.S. and the world are using more petroleum than ever. World demand for oil grew over 15 million barrels per day (mmb/d) during the past ten years. Overall, U.S. petroleum demand is projected to grow from 19.5 mmb/d in 1999 to 25.8 mmb/d in 2020. Currently, the U.S. imports approximately 50% of its crude oil requirements; these are projected to increase to 66% by the year 2020. Nevertheless, world reserves remain healthy. The reserves/production ratio is the length of time that proven reserves will last if production and consumption continue at their present rate (holding both technology and reserve levels unchanged). Despite increasing

global consumption, this ratio rose steadily towards 40 years throughout the 1970s and 1980s and is presently at 41 years.[6] Advances in exploration and production have increased world proven reserves from 700 billion barrels to over 1 trillion.[7] These reserves also increase as the price of oil increases, as areas that are more costly to access become economic. Geologists estimate up to two-and-a-half trillion barrels of "potential" in the world if oil gets more expensive.[8] Moreover, many areas remain unexplored in Alaska, Africa, Russia, Iraq, Saudi Arabia and the UAE. No one really knows how long this oil will last, but MIT Professor M.A. Adelman, might just be right when he says, "The world will never run out of oil, not in 10,000 years."[9]

If there is so much crude oil, why are gasoline prices rising sharply? Crude oil is not usable in its raw form; it must be refined into gasoline, kerosene, heating oil, or other petroleum products suitable for consumption. Refineries in the U.S. are operating close to maximum capacity, running in 1999 at about 93%.[10] Additionally, refined products are not all the same. For example, the U.S. has 34 different or boutique blends of gasoline, making gasoline less fungible and interchangeable between regions.[11] Furthermore, we have not built a new refinery in this country in the last 25 years. Some suggest siting a new refinery in the U.S. may be nearly impossible due to environmental and NIMBY (not in my backyard) concerns. Refiners are also taking advantage of market forces and reducing inventory storage to the minimum to mitigate environmental liability and reduce overhead. All these factors contribute to current high gasoline prices.

Overall, world crude oil reserves are healthy and most energy forecasts project affordable and available crude oil for the foreseeable future. However, the majority of U.S. oil must be imported because of rising demand and flat or falling U.S. production. This crude oil needs to be refined and U.S. refineries are running near capacity. The lack of refinery capacity along with many different regional fuel blends cause local shortages and high regional gasoline prices.

Coal

Coal is a vital component of our energy strategy: coal fired power plants produce 55% of U.S. electricity.[12] Coal is plentiful and relatively inexpensive. Proven reserves will last over 250 years at current levels of consumption.[13] A vast domestic supply and infrastructure greatly assists in meeting our current and future electricity demands. Without coal, the U.S. would be even more dependent on foreign energy sources.

Coal mining productivity has increased 22% since 1986 with prices dropping 46% in real dollars.[14] Coal is mined underground and from the surface in many areas of the U.S. Huge open pit surface mines dominate the Powder River Basin area of Wyoming, while smaller underground mines are prevalent in the interior and Appalachian regions.

Environmental concerns will be the key to the coal industry's future. Relative to other fossil fuels, coal is less energy efficient and pollutes more. Clean coal technology promises to greatly improve efficiency and reduce emissions but will be expensive to retrofit into existing plants. Electricity deregulation will force coal-fired power plants to be become more competitive, as they make the difficult decisions to invest in capital-intensive improvements to meet Clean Air Act Amendments requirements.

Government policy will play a key factor in coal's future. Externalities and regulations will continue to affect the industry and the marketplace. A wise strategy will capitalize on this national resource and balance the need for economic growth and energy security with protection of the environment. Without coal as part of a diverse energy mix, the U.S. would be in a more precarious position with respect to energy security. An attached essay analyzes the effect of environmental regulations on the coal industry.

Natural Gas

From its beginning as a nuisance while drilling for crude oil, natural gas has now become one of the most abundant and widely used fuels in the U.S. Today it provides nearly one-fourth of all energy consumed in our country. Since 1989, following natural gas deregulation, the industry has experienced strong growth. According to the EIA, proven dry gas reserves in the lower 48 states and Alaska are estimated to be 1,278,822 billion cubic feet (bcf) and 25,649 million barrels of natural gas liquids.[15] At projected consumption rates, this reserve will largely meet U.S. gas requirements for the foreseeable future.[16]

To find new sources of natural gas, producers are exploring in the Gulf of Mexico, offshore eastern Canada, Western Canada, the Mackenzie Delta, Beaufort Sea and the Alaskan North Slope.[17] Technological improvements have spurred producers to tap nontraditional or "unconventional" gas formations, including tight sands, Devonian shales and coal-bed methane.[18]

Fortunately, these considerable natural gas supplies satisfy 87% of our current demand. Canada provides most of the remaining 13%.[19] In spite of plentiful reserves, natural gas prices have soared in the last few years for several reasons. First, most new power plants burn natural gas and as the economy expanded, demand has increased. Second, because natural gas prices were low from 1995 until 1999, there was a corresponding slowdown in gas exploration. As a result, production is now lagging and natural gas prices are 300-500% higher in 2001 compared to prices before 1999.

In summary, the impact of the natural gas industry on the U.S. economy and our national security is significant and will become ever more so in the future. An attached essay will discuss the U.S. Government's future role regarding the natural gas industry.

Nuclear

Nuclear power is enjoying a bit of a renaissance in the U.S. Currently, 103 nuclear power plants provide approximately 20% of U.S. electricity generation capacity,[20] and they are running better than ever. In 1999, U.S. nuclear power plants achieved an average capacity factor of 86.8%; this is 29 percentage points higher than the 1980 average.[21] Nationally each percentage point increase in the capacity factor is roughly equivalent to bringing another 1,000 megawatts of generating capacity online.[22] A well-managed nuclear unit can produce electricity very profitably and currently, on average, nuclear power provides the lowest-cost electricity in the country.[23]

Not everything is rosy, however, for the nuclear industry. No new power plants have been ordered since 1978, primarily due to safety concerns, stemming from the Three Mile Island accident in 1979. Additionally, economic factors also contributed to nuclear power's decline. The promise of nuclear power "too cheap to meter" never materialized. In reality, nuclear power plants became increasingly costly to build between the mid-1960s and the mid-1970s.[24] Additionally, following the Three Mile Island accident, many units were forced into costly design changes and equipment retrofits. By the end of 1999, 124 units had been cancelled, 48% of all ordered units.[25]

Waste is another issue clouding nuclear power's prospects. Currently, all spent nuclear fuel is stored on-site at power plants. The Federal government has not yet made a final decision on when a waste repository will open. We believe that ultimate approval for long-term storage of waste at Yucca Mountain in Nevada will resolve this controversial issue.

The outlook for operating license renewals appears positive. U.S. nuclear power plants are licensed by the Nuclear Regulatory Commission (NRC) to operate for 40 years. Owners/Operators may renew their license for an additional 20 years if approved by the NRC. To date, the owners of approximately one-third of nuclear power plants are pursuing license renewal and more are expected to follow.[26] The surge of interest in license renewal is a product of

restructuring, competition and regulatory overhaul. A deregulated, competitive electric generating business creates a powerful business incentive to renew a nuclear plant's license. A well-managed nuclear plant can produce electricity at costs substantially below other sources. In the new competitive environment, these plants have now become very financially attractive.[27]

Long regarded as a white elephant by the industry, nuclear power is now enjoying a rebirth under deregulation. The recent focus on emissions of greenhouse gases and improved safety and operating performance has renewed interest in this promising source of energy.

Renewables

Renewable sources of energy include hydroelectric, biomass, geothermal, solar and wind. In total, they supply approximately 10% of the country's energy needs.[28] The Department of Energy projects the greatest growth in renewables by 2020 to take place in municipal solid waste (MSW) and biomass, wind and geothermal.[29] Solar power continues to grow but is estimated to remain at less than 1% of total electricity generation through 2020.[30]

During our visit to BP Solar in California, plant officials indicated that improvements in photovoltaics could lead to solar panels imbedded in building materials, thereby reducing peak load demands on the transmission grid. Besides the impact that renewables can have on networked electricity, the industry has a significant niche in supplying small loads in remote areas not connected to the grid. Currently, up-front investment costs generally make renewables, other than hydroelectric, commercially unattractive in comparison to those of fossil fuels. This dynamic may change with technological advances, electricity deregulation and variations in fossil fuel costs. Renewables' current niche market serves a very beneficial supply role and with the right government stimulation, their future growth may exceed projections.

MAJOR ENERGY ISSUES

Short Term Energy Crisis

The price of crude oil climbs over thirty dollars per barrel. California suffers rolling blackouts. Some of the Strategic Petroleum Reserve is released to mitigate a heating oil shortage in New England. Gasoline prices spike to over two dollars per gallon, natural gas heating bills double. The Secretary of Energy says we are in an energy crisis and he is correct - we are in a short-term energy crisis.[31] Unlike previous energy shortages/crises, this most recent disturbance has little to do with a world crisis or lack of world energy supplies. It has primarily occurred due to domestic mismanagement and inaction. Some of the specific problems are discussed below.

Historically low prices for natural gas during the last decade have resulted in stagnant production growth. When demand increased beyond existing production capacity, large price increases occurred. In response to higher natural gas prices, there has been a significant increase in exploration activity. However, exploration and construction lag times will continue to cause natural gas to remain expensive for the next couple of years until new production reaches the market. Natural gas prices should start dropping by 2003.

Gasoline prices are currently high primarily due to the shortage of domestic refining capacity. The lack of refining capacity coupled with non-fungible gasoline blends have led to regional gas shortages and price spiking. Expanding refinery capacity and reducing the number of regional gasoline blends are the best solutions to lower gasoline prices.

Besides short-term price spikes in oil and natural gas, we also are experiencing difficulties in electricity generation and transmission. The growth in U.S. consumption of electricity has outpaced production for the last several years. Since deregulation, the electric company's old regulated mantra of "an obligation to serve" has been replaced with a focus on cutting excess

capacity to reduce costs. Although this focus can help deliver lower prices to consumers, structure and incentives must be provided to ensure the country maintains sufficient capacity (including reserve capacity) to meet our growing needs. In the past, excess generation capacity was stipulated by the regulatory authorities. Under deregulation, firms do not have financial incentives to maintain excess capacity. Barriers to building new power plants, especially environmental or NIMBY concerns, need to be balanced against the adverse economic impact of not building additional generating capacity. Further, retail prices need to be tied to wholesale rates to link consumer behavior to financial incentives to build more capacity. An attached essay discusses the status of deregulation in the U.S. electricity industry.

Just in time inventory, while efficient, makes the system much more prone to shocks and this phenomenon applies to most energy sectors (i.e., less peak demand capacity). Deregulation leads to more efficiency, but it also leads to systems with less back up and greater instability.

Some have suggested that price caps, tax reductions and additional governmental intervention will help solve our short-term energy situation. We feel that those measures would be counterproductive and inhibit rather than facilitate resolution. Actions such as removing barriers for refinery construction and reducing the number of gasoline blends are better solutions. With respect to electricity, ensuring retail prices are tied to wholesale rates combined with additional infrastructure are the quickest ways of stabilizing electric energy supplies. Give the laws of supply and demand a chance to work their magic.

Energy Supply Security

Although the level of crude oil imports to the industrial nations has continued to rise, the share of world crude oil supplied by the Organization of Petroleum Exporting Countries (OPEC) declined from 1976 to 1985 but has been generally rising slowly since then. OPEC's market share is not expected to surpass 1976 percentage levels until 2020.[32] Part of the resilience of non-OPEC production stems from improved upstream technologies, which have reduced finding and production costs. The U.S. imported approximately 30% of its crude oil in 1973 with a large majority coming from Arab OPEC members. Today the U.S. is importing approximately 50% of its oil requirements with only 16.6% of them coming from Arab OPEC members.[33] The data suggest that although the level and percentage of U.S. imports continue to rise, our supply diversity has also risen. A wildcard in the scenario is the continued relative political stability of the large OPEC producers. If a radical/fundamental regime were to take over a country such as Saudi Arabia, the world at large may experience a short-term world petroleum shortage. "Short-term" is used because it is our belief that under any credible situation an oil-rich country will ultimately sell to the world market.

Another change has been the growth of the world's oil commodity exchanges. Crude oil is truly fungible and continually traded over the entire globe. These exchanges promote supply stability and mitigate the potential for unilateral embargos. If country X wanted to embargo country Y, country Y would only have to go to an exchange to replenish its lost source. As long as the aggregate level of world oil production is not significantly affected, there will be oil for sale on an exchange.

Lastly, our visit to the Middle East confirmed three particular points. First, the U.S. will continue to play a dominant role in maintaining the free flow of oil throughout the world, particularly through the Straits of Hormuz. Second, sanctions and embargoes can hurt energy supply security and U.S. business interests. Third, encouraging and stimulating a diverse energy supply mix should mitigate U.S. vulnerability to foreign oil disruption. This diversification will buffer the U.S. economy from major supply disruptions. The distinction between dependence and vulnerability suggests that diversity of supply is a key factor for security.

Infrastructure

America has an energy infrastructure problem. Red tape, environmental laws, lack of market incentives to make capital investments and hostile homeowners make it difficult to build new refineries, pipelines, power plants, high-voltage lines and other essential elements of the energy network. As a result, existing infrastructure is being used in ways for which it was not designed and distribution bottlenecks are becoming ever more prevalent.

In the electricity sector, the U.S. needs more and better delivery infrastructure in order to reap the benefits of competitive electricity markets. According to some industry experts, the development of the U. S. transmission infrastructure has lagged far behind other developments in the electricity industry. Inadequate infrastructure means the nation will increasingly experience limits on the ability to move power around the country. Therefore, areas like California that experience supply shortages will not be able to use surplus energy from areas having ample capacity. Thus, even if competitive electricity markets were the goal, the limitations of the transmission system seriously restrict the ability of the market to operate efficiently. The challenge is to develop a robust transmission system to support increased demand and reliability.

In the natural gas arena, there are similar infrastructure shortfalls. For example, there is insufficient pipeline capacity from the supply basins to the demand centers. According to EIA, the current pipeline system will not support additional gas transmission requirements. Furthermore, industry experts indicate an investment of about $34 billion in interstate pipeline and storage infrastructure is the minimum necessary to maintain pace with market demand. This translates into an average of 2,000 – 2,100 miles of new gas pipelines each year.

The U.S. is also facing daunting challenges in the refining sector. Operating near maximum capacity, there is little reserve or surge capability to deal with even normal market perturbations, let alone significantly increasing demand. To meet forecast demand, EIA estimates an additional 1.7 mmb/d of refining capacity will be required by 2020.[34] This translates into either expanding existing capacity or adding new facilities. If the latter, EIA estimates the U.S. will need as many as 10 new refineries. However, no new refineries have been built in the U.S. during the last 25 years and financial, environmental and legal considerations make it unlikely that will change anytime soon. Therefore, expanding capacity at existing refineries will likely be the only way to increase total U.S. refining capacity.

Environment

Over the next 20 years, EIA estimates U.S. energy demands will increase by 62% for natural gas, 33% for oil and 45% for electricity.[35] Yet as consumption surges, production in some areas continues to decline.[36] The reasons for diminishing supplies are largely tied to environmental concerns. Florida, for example, appears determined to block Federal oil and gas leasing off its shores in the Gulf of Mexico because oil and gas drilling is "dirty business." Similarly, an increasing amount of Federal lands in the Western U.S. are effectively off-limits to drilling and production due to environmental concerns.

One of the largest challenges facing the U.S. concerns environmental regulations regarding global climate change. Significant improvements are expected in the reduction of sulfur- and nitrogen-related pollutants. Fossil fuel energy projections, however, imply a steady increase in CO_2 emissions. If indisputable evidence develops that CO_2 has a catastrophic effect on the global climate, our energy security and stability would be severely affected. In particular, the U.S. coal industry would bear the brunt of the burden as the largest single producer of CO_2.

Taken one at a time, decisions that are environmentally friendly can seem prudent. In the aggregate, however, they form a pattern of systemic resistance to the development of energy supply and serve as an effective barrier to energy production. Such actions, according to Senator

Pete Domenici of New Mexico, have made the U.S. "the most difficult and expensive place in the world to build a power plant."[37]

POLICY RECOMMENDATIONS

1. Foster a diverse energy supply mix by permitting market factors to take effect and use policy to stimulate development of nuclear, renewable, clean coal and other advanced technologies. U.S. energy security is directly linked to diversity of supply.

2. Apply cost-benefit analysis and sound science when making environmental policy decisions. Also, ensure policies properly price externalities into the market as opposed to regulating them separately. It has been shown that capturing the full cost of externalities in the price of the commodity is the most efficient means of maintaining the linkage between supply and demand.

3. Normally, let markets work. When governmental intervention is deemed necessary, ensure it incorporates common standards. For example, the U.S. should standardize fuel specifications to reduce the number of boutique blends, making refined products more fungible between regions. Currently regional unique gasoline blends make it very difficult to shift product from areas of low demand to areas of high demand. The Federal government under its constitutional powers to regulate interstate commerce should establish more common gasoline blends to facilitate the free flow of product between regions. Additionally, on a broader topic of overall regulatory diversity, the Federal government should assist in the standardization of differing environment regulatory requirements between regions. This will have the same effect of facilitating the free flow of goods and services between regions.

4. Stimulate research and development in the energy industry including sponsorship of public/private partnerships into more energy efficient generation and consumption technologies. Market driven incentives should be explored to replace aging and inefficient infrastructure with state-of-the-art technology. Additionally, government sponsoring of leading edge technologies (including pollution mitigation methods and consumption efficiency gains) are appropriate and should be expanded. Furthermore, tax incentives should be granted to stimulate the commercialization of promising technologies.

5. Revisit international sanctions and embargos. Major oil reserves currently reside in embargoed countries. American industry and citizens are being penalized due to lack of access. In many international energy-rich regions, the U.S. has imposed unilateral sanctions and/or embargos, which reduce U.S. energy diversity and thus national security. The greater number of potential energy suppliers we possess, the lower our risk of supply disruption. These actions also have the effect of lowering our commercial competitive advantage as foreign companies, not restricted by our laws, openly exploit these opportunities. On a foreign policy note, there is growing evidence that unilateral sanctions and embargoes by the U.S. have marginal utility in affecting the kind of behavioral change we desire.

Attached below are three essays that cover specific topical areas affecting the U.S. energy industry. An overall conclusion follows the essays.

Coal-Fired Generation: Essential, Affordable, and Potentially Clean
By Anonymous

While energy is important, it also causes harmful effects to the environment. According to the World Resource Institute, energy related emissions account for more than 80% of the carbon dioxide released into the atmosphere each year. Since fossil fuels supply roughly 90% of the world's commercial energy, rising energy use may cause an increase in harmful greenhouse gas emissions and possible increase in global warming.[1] Thus, while energy is essential to industrialization and a key contributor to economic prosperity, its production and use may also adversely affect the environment. Consequently, affordable, adequate, and environmentally benign supplies of energy are critical to our nation's economic, environmental, and national security.

Coal offers a solution. It is America's most abundant domestic energy resource; the cheapest source of fossil fuel energy per British thermal unit (Btu) averaging less than half the price of petroleum and natural gas, is becoming an environmentally-friendly fuel. It provides over 50% of the electricity consumed in the U.S. per year; and contributes over $3 billion to the U.S. balance of payments.[2] No major energy source, however, is without its challenges, and coal is no exception. Strict environmental regulations, more competition from increasingly cost-effective alternatives, and the newly competitive electricity markets will provide significant challenges.

Environmentally, coal-fired electric generating units emit gases that are of concern. In 1998, U.S. carbon dioxide emissions from the combustion of coal for electric utility generation were nearly half a billion metric tons of carbon, 32% of total carbon dioxide emitted from all U.S. fuel sources.[3] Modern technology has helped eliminate significant amounts of pollutants from the burning process. For example, while coal use for domestic electricity has almost tripled since 1970, government statistics show sulfur dioxide emissions have decreased more than 20% below 1970 levels.[4] Additionally, using other advanced technologies, the coal-based electricity industry has improved its environmental efficiency by nearly 70%.[5] When the final reports are in, the U.S. Environmental Protection Agency (EPA) believes emissions of criteria air pollutants from coal-based generation will be one-third less in 2000 than they were in 1970, despite a three-fold increase in the use of coal.[6]

ENVIRONMENTAL REGULATIONS

The major chemical makeup of coal, which includes carbon, hydrogen, and oxygen, also contains impurities, such as minerals and sulfur. These impurities have been a major concern because they contribute to the pollutants produced during coal combustion. Many people thought coal would not overcome this challenge. The coal industry estimates that $30 billion has been spent on environmental remediation technology since 1970.[7] Surprisingly, even with that significant investment, coal remains the most economical fuel for making electricity.

Electricity producers must comply with the 1990 Clean Air Act Amendments. The Phase I amendments set new Federal regulations on sulfur dioxide (SO_2) emissions at 2.5 pounds per

---

[1] World Resource Institute. "Power Surge: Energy Use and Emissions Continue to Rise," http://www.wri.org/wri/trends/emissions2.html

[2] National Mining Association, "Fast Facts About Coal," http://www.nma.org

[3] U.S. Department of Energy, Energy Information Administration, Carbon Dioxide Emissions from the Generation of Electric Power in the United States, July 2000.

[4] Americans for Balanced Energy Choices, "Increasingly Clean," http://www.balancedenergy.org

[5] Ibid.

[6] Ibid.

[7] Harlan S. Byrne, "New King Coal," Barron's, Oct 9, 2000.

MMBtu. Phase II regulations effective in January 2000 capped SO_2 emissions at 1.2 pounds per MMBtu. Power plants were allocated SO_2 credits of 1.2 pounds per MMBtu calculated from their fuel used during the 1985 to 1987 base period. Plants constructed after 1996 are not allotted emissions allowances. Power plants that do not meet these standards can retrofit with flue-gas-desulfurization systems, use low sulfur coal, purchase emissions credits, or close. If a power plant's emissions are below its allotment, it may sell its excess. More recently, the EPA promulgated regulations for nitrogen oxide (NO_x) emissions in 22 Eastern and Midwestern states on a state-by-state basis, beginning in 2004. The coal-fired generation industry has been very successful implementing new technologies and procedures to comply with the Clean Air Act Amendments and is on track to meet all regulations.[8]

The biggest environmental challenge facing the coal industry is the issue of greenhouse gases, specifically carbon dioxide (CO_2). Since U.S. has not termed CO_2 a pollutant, no regulations have been promulgated. Most potential investors believe laws will limit CO_2 emissions in the future. Until this issue is resolved, the probability that many coal fired power plants will be built is minimal.

The Department of Energy is charged with protecting the Nation's energy interests. Through its Clean Coal Technology Demonstration (CCT) Program, DOE has vigorously researched and promoted ways to reduce the environmental impacts associated with coal. Specific goals of the CCT Program include increasing the efficiency of electricity production and enhancing the efficient and cost effective use of U.S. coal reserves, while ensuring achievement of national and environmental goals.[9]

NEWLY COMPETITIVE MARKETPLACE

A deregulated electricity generation industry should naturally cull out dirty, inefficient existing power plants. Consolidation is being driven by the unbundling of the electricity generation and distribution industries. Inefficient power plants that are too costly to be compliant with environmental regulations will close. Cost will be the driving factor, not system reliability.

Stiff competition in many markets should drive down the cost of coal for power generation. This includes reducing the cost of coal mining, improving generation efficiency, and reducing environmental compliance costs through technological improvements. However, new coal burning generation competes with nuclear, natural gas, and renewable powered generation. The price and quantity of nuclear electricity remains stable, but new plants are currently prohibitively expensive. Renewable power generation will likely double from its current level, but still only provide a small percentage of the total electricity supply. Clean natural gas was attractive when it was cheap, and became the power plant fuel of choice in the 1990s. New coal power plants were not built because:

- Coal power plants cost more to build than gas plants;
- Coal plants take about 4 years to build versus 2 years for a gas plant;
- Even new coal plants still produce NO_x, SO_2 and ash.

The case for coal today and into the foreseeable future, however, is primarily one of price competitiveness. In 2000, natural gas prices peaked at $6.51 per MMBtu. Coal, by contrast,

[8] U.S. Department of Interior, Forces Shaping Future U.S. Coal Production and Use, (USGS Fact Sheet FS-158-00, December 2000).
[9] United States Environmental Protection Agency, Sector Notebook Project, Fossil Fuel Electric Power Generation, Washington D.C., 1999, Section II, p. 73.

remained at approximately $1.20 per MMBtu.[10] The relative price advantage of coal gives it an edge as the baseline power generation fuel of choice. Since demand for electricity continues to grow at better than 2% a year and gas prices are expected to remain at least twice the cost of coal per MMBtu, coal should continue as the most economic generating fuel, barring any new unanticipated environmental restrictions.[11]

FUTURE TECHNOLOGIES

The coal and electric industries have responsibilities to partner with government and solve coal's remaining environmental problems. The Department of Energy's Vision 21 plan provides a roadmap for the future. This sweeping energy plan drives research and development for the next generation of energy plants. Assuming this technology is viable, new plants will be cleaner, more efficient and flexible enough to burn different fuels with negligible emissions. Vision 21 lays out ambitious goals for increasing energy-generating efficiencies to 60% for coal and 75% for natural gas.[12] Promising technologies for coal are being demonstrated in phase two of the three-phase program, including advanced pressurized fluidized bed combustion and integrated gasification combined cycle (IGCC) plants. Both types of plants increase the energy efficiency well beyond the 33% attained by conventional coal burning plants.

Fluidized bed combustion allows any kind of fuel to be burned while controlling the emission of SO_2 without the use of a flue gas scrubbing device. IGCC technology is even more environmentally friendly. In an IGCC plant, coal is converted into a gaseous fuel, purified, and combusted in a gas turbine generator to produce electricity. The environmental advantages of IGCC include higher efficiency, and removal of nitrogen, sulfur and particulates prior to the addition of combustion air.[13]

Since CO_2 cannot be "scrubbed out" of fossil fuel combustion, the only effective approach is to improve burning efficiency. The most promising technology for improving efficiency is cogeneration. The typical efficiency at a fossil fuel electric plant is around 33-38%, but cogenerators can obtain up to 80% efficiency. This is analogous to going from 25 miles per gallon to 50 miles per gallon in car-efficiency terms. The heat recovered from the flue gases is used rather than wasted. Although cogeneration facilities were originally for industrial applications, they are increasingly being designed as merchant power plants and thus compete with utilities.[14]

CONCLUSION

The coal industry has an image problem. Old stereotypes and Hollywood portrayals such as *October Sky* and *Coal Miner's Daughter* put the industry in a bad light. A recent West Virginia newspaper article pinpoints the struggle coal faces by stating, "It's not hard to understand why coal has long had a bad rap: It's dirty, dangerous to mine and despoils the environment. Besides, coal-fired electric power plants pollute the air."[15]

This image can be overcome by emphasizing pollution prevention technology and improving public perceptions. Coal is a vital contributor to meeting our energy needs. A vast domestic supply and in-place infrastructure gives the U.S. economy a competitive advantage. Proven coal reserves will last over 250 years at current levels of consumption, making coal our

---

[10] Patrick McGuire, "A Comeback for Coal," Business Week, December 11, 2000, p. 112C.
[11] National Coal Council, Vision 2020: The Role of Coal In U.S. Energy Strategy, February 18, 1997, p. 27.
[12] Gale Morrison, "Energy Renewal," Mechanical Engineering, July 1999, p. 11.
[13] United States Environmental Protection Agency, Sector Notebook Project, Fossil Fuel Electric Power Generation, Washington D.C., 1999, Section II, p. 75.
[14] Ibid., p. 78.
[15] Frank Reeves, "Energy Crisis Gives Boost to Coal Industry's Fortunes," Pittsburgh Post-Gazette, Feb 13, 2001.

most abundant fossil fuel.[16] Without coal, the U.S. would be even more dependent on foreign energy sources and national security would be more at risk. Reliable, low-cost U.S. electricity remains an element of national power that feeds economic growth. The key to a successful national energy policy is the proper balance of research, exploration, efficiencies, and government enforcement of environmental regulations.

United States Electric Power Industry
By Jim Moreland, Department of the Navy

This essay addresses the current conditions in the U.S. electricity industry. In the current electricity restructuring environment, developing and maintaining a robust electricity supply system require a fine balance among four primary objectives: supply reliability, reasonable economic cost, sound market structure and minimal environmental impacts. Electricity is the energy source that drives our modern economy; both the new economy of electronic commerce and information exchange, and the old economy that it supports.

BACKGROUND

Electric Power Physical Infrastructure

While the U.S. does not have a fully interconnected national grid, the infrastructure permits the electricity generated at many U.S. power plants to be delivered widely within the continental U.S. This process begins with the production of electric energy from other energy sources. The transmission grid then disperses this high voltage electricity to different U.S. regions. Above-ground or underground power lines carry the electricity to distribution substations where transformers reduce the voltage. Thereafter, local distribution lines receive the lower voltages for further distribution to the U.S. population.

The North American power system contains 157,810 miles of high-voltage wires, towers, transformers and substations. This power grid consists of three interconnections: Eastern, Western and ERCOT (Texas). The Eastern and Western interconnections have several high voltage direct current (HVDC) connections, and the Eastern and ERCOT interconnections have two HVDC connections. Over the past 25 years, construction of power lines declined while electricity demand and new power plants rose, making the system inadequate for current expectations. Bottlenecks within this system cause rolling blackouts due to the lack of capacity along the lines to move additional electricity either to satisfy increased demand locally or to import emergency power from other regions.

Complex control systems exist to enhance reliability by regulating the flow of electricity across the transmission and distribution grids. Control systems balance demand and generation and ensure electricity flows and voltages stay within safe and stable limits. Some other basic correction measures built into the systems for reliability purposes are "cross ties" and "relays."[1] Problems in reliability are apparent from the amount of transmission loading relief (TLR)

[16] Des Clifford, "World Coal," The Mining Journal LTD, September 2000.

[1] "Cross ties" connect areas served by single power lines for back-up purposes to prevent large groups of people from losing power due to line damage. These connections allow for the rerouting of electricity from a different source. "Relays" are another corrective device, which disconnects a part of the system experiencing faults from the remainder of the network.

procedures that occur.[2] In 1998, the grid experienced 300 TLRs, in 1999 over 500 TLRs, and in the first 9 months of 2000 experienced over 900 TLRs.

Deregulation

The gradual deregulation of industries has had profound and pervasive influence on lowering inflation, expanding economic growth and raising living standards.[3] The U.S. is in the process of fundamentally restructuring the way the electric power industry operates by unbundling the vertically integrated electric utilities. This effort will reduce the cost of electricity and increase choice as competitive markets develop for wholesale and retail power.

The California electricity crisis, however, raises doubts about the structure of the electricity market and the overall benefits of electricity competition. There are three main flaws evident in California that do not condemn competition per se: deregulation structural problems in market design, lack of new generation and transmission additions, and regional demand growth. California's market structure problems arose from the failure of retail prices to reflect changes in wholesale electricity prices. Utilities and non-utilities face capped retail prices to customers, but wholesale prices fluctuate in response to supply and demand forces.

Environmental Impacts

Energy-related pollution and environmental damage need mitigation without causing substantial increases in electricity prices, but the latter may be difficult to achieve. According to DOE, environmental compliance costs will increase by seven-fold to over $13 billion per year by 2010. If power plants and transmission towers are both deemed eyesores and environmental hazards, the common NIMBY (Not In My Back Yard) syndrome escalates to BANANA (Build Absolutely Nothing Anywhere Near Anything).

The electric power industry is a major source of air pollution and greenhouse gases. Power plant emissions account for more than 80% of total U.S. greenhouse gas emissions, and most of these are due to generation from coal and petroleum. Future electricity demand levels together with the implementation of air quality regulations will impact new supplying firms and thus market structure.

INDUSTRY OBJECTIVES

Supply Reliability

The North American Electric Reliability Council (NERC) defines the reliability of the interconnected bulk power systems in terms of two functional parameters: adequacy[4] and security.[5] Reliability depends on a variety of factors, including fuel availability, generation capabilities, supply and demand balance, transmission and distribution capacity and maintenance, and market response.

The lack of new generation and transmission additions stems from the increased risk accompanying electricity restructuring. Some of this risk develops from regulatory commissions

[2] A TLR occurs when a line is about to be overloaded, causing damage to the line and other equipment connected to the line.
[3] Richard B. Belzer, Independent Regulatory Oversight: A New Path to Regulatory Reform (St. Louis: Washington University, Center for the Study of American Business, February 1999).
[4] The ability of the electric system to supply the aggregate electric energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.
[5] The ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements defines this element of reliability.

retroactively declaring an investment imprudent, resulting in "stranded costs."[6] The new thinking under deregulation focuses on rate of return strategy rather than on the traditional cost-of-service strategy. In view of the uncertainties in California and elsewhere of earning adequate returns on new investments, a virtual freeze on new generation and transmission development occurred. In addition, a cumbersome approval process for new generation siting, together with opposition from environmental activists and local communities, also depressed infrastructure investments.

Fuel availability depends on the following essential elements: the abundance of the world's natural resources, dependence on transportation for delivery, and the security environment in obtaining natural resources throughout the world. Generation capabilities depend in turn on the technology and reliability of the machinery used as well as on market forces.

Distributed generation is growing rapidly in many countries due to the development of efficient small-scale generation with clean technology and the incentive of increased reliability. DOE's goal for distributed energy is to develop the cooperation and technology to enable these systems to provide at least 20% of the nation's new power by the end of the decade. A distributed system produces electricity close to the load center, providing benefits such as lower economic size, high power quality, improved reliability and reduced need for long-distance transmission, as compared with large centralized units.

Reasonable Cost

The new Secretary of Energy, Spencer Abraham, noted our nation's last three recessions were tied to rising energy prices, and the most recent slowdown in GDP growth is also correlated with higher energy costs.[7] The goal of deregulating the U.S. electricity market was to promote a competitive environment and thus lower prices to consumers.

Instead, under the state's flawed system, California's generators increased their prices due to the current imbalance between supply and demand and capped retail prices. Another unfortunate fact in the economic market is that the increases in the price of one good will trigger others elsewhere. Such was the case in the natural gas market in California, which also experienced abnormally high prices due to the heavy dependence on gas to provide electricity.

Sound Market Structure

The electricity market should operate normally without any disruptions from regulations or legislation. Any required regulation or legislation should apply cost-benefit analysis and sound science and do so to common standards. The consumer needs to pay a price that reflects total costs, including externalities, at the retail point of sale.

The balance between supply and demand has huge implications on the success of market structure goals. Policy on electricity supply should be used to foster a diverse energy supply mix and to stimulate infrastructure growth, alternate fuels and advanced technologies. On the other hand, demand-side management (DSM) needs a strong push from the federal government. DSM could become a strong driver in load management as companies look for opportunities to sell the reserves resulting from effective DSM programs.

[6] Stranded costs mean the costs that become uneconomical to recover through rates due to regulatory changes. They arise in competitive markets from uneconomic assets, the costs of which are not recoverable at market rates.

[7] Spencer Abraham, "A National Report on America's Energy Crisis," Remarks by U.S. Secretary of Energy at U.S. Chamber of Commerce, National Energy Summit, 19 March 2001.

Environmental Compliance

Generators weigh the costs and benefits of reducing pollution. Often, pollution is not priced by the market, and companies find it cheaper to pollute their surroundings than to produce cleanly. Eventually, however, the costs of pollution as externality pass on to society in the form of health costs and discomforts suffered by people. The EPA has implemented the Clean Air Act of 1990 and its amendments.[8] Polluters have their cost base increased by tax charges while environmentally responsible producers receive subsidies to reduce additional social costs. This intervention has "internalized" the external costs of pollution. To find a viable alternative to the Kyoto Protocol, the U.S. should lead the international debate on environmental compliance issues.

CONCLUSION

Electricity is the bloodline for our nation's economic growth – without this necessity, both productivity and prosperity will decrease. The present electricity sector is experiencing a constant increase in supply disruptions due to the inadequate infrastructure network–poor reliability factor. Ultimately, this will lead to brownouts and blackouts across the nation, together with lost productivity and a poorer quality of life for all Americans. The combination of competition, tight capacity margins, and increased demand on the U.S. electric power infrastructure reinforce the importance of maintaining system reliability. The current restructured electricity sector will continue to operate in a complacent mode toward reliability with full attention on the profit margin.

Finally, the U.S. needs to promote a healthier environment (air quality) but also strive to drive the generation market towards optimizing the energy conversion process. With the optimization of electricity production comes higher efficiencies and therefore lower consumer prices.

U.S. Government's Role in the Natural Gas Industry

By LTC Richard A. Smart

Natural gas is a key energy source that has fueled U.S. economic development for the last three decades. It is one of the most abundant fuels in the U.S. and currently provides nearly one-fourth of all energy consumed in the U.S. The substitution of natural gas for other fossil fuels has eased both a number of environmental concerns as well as those regarding our dependency on oil. In just the last decade alone, natural gas use has increased by 35% and is expected to increase another 45% by the year 2020.[1]

As a result of our growing use of natural gas, gas price fluctuations "ripple" through all sectors of the U.S. economy. As the California experience demonstrates, recent price spikes have spurred debate as to whether a more "government-centric" economic strategy should be implemented to avert short and long term natural gas and other energy price increases. Additionally, consumers look to the government to address perceptions of attempts by greedy companies to gouge consumers. As tempting as utility re-regulation may appear, past bouts with

[8] The Clean Air Act regulates emissions of conventional air pollutants from electric utilities. While it has historically focused on new construction in applying its most stringent standards, several current and prospective regulations would significantly increase controls on existing, coal-fired facilities. The program instituted under the Clean Air Act Amendments of 1990 employs a unique, market-based approach to sulfur dioxide emission reductions, while relying on more traditional methods for nitrogen oxide reductions.

[1] American Gas Association, Natural Gas Facts, AGA/Advocacy Issues, March 24, 2001, http://www.aga.org/IssueFocus/NaturalGasFacts.html

government centrally-planned solutions have resulted in less consumer choice and higher prices over the long run. Despite the lessons learned from past initiatives to regulate the natural gas industry, government must implement supply and demand policy strategies to protect consumer interests, reduce national security vulnerabilities and promote economic growth.

THE PAST AND PRESENT SITUATION

Federal and state governments play an important role in the natural gas industry. In the past two decades, for example, the North American natural gas industries have undergone many regulatory changes. The fluctuation in prices and movements to a more market-centric economy coupled with growing fuel competition led to increased perceptions that natural gas can be managed like a commodity.[2] As such, the government began to ease regulatory price caps in both upstream and downstream sectors of the industry. These regulatory changes have led to a more open and competitive gas supply industry, a restructured interstate pipeline business, and a broader array of supply and transportation choices for gas consumers.[3]

Despite past successes with deregulation, natural gas prices have soared in the last few years. Prices have increased so dramatically that many consumer advocates are beginning to ask why the government is not stepping in to bring prices down to pre-1999 levels. Rising prices are not the result of market power, since this industry has many buyers and sellers; rather, consumers are witnessing what happens when supply and demand imbalances exist in a free market economy.

Both wholesale and retail gas prices began to rise in response to growing consumption. In recent years, most new electricity generating facilities burn natural gas. More generally, as the economy expanded, the demand for gas rose. On the supply side, U.S. gas exploration and production lagged behind demand[4] due to depressed prices from 1995 to 1999.[5] As a result, storage levels fell. Today's higher prices have already triggered rising exploration, and the new supplies are expected to ease prices and rebuild stocks within the next two years or so.

GOVERNMENT'S FUTURE FOCUS

Given the growing strategic significance of a reliable and affordable supply of gas, the U.S. government has a role in developing both supply and demand side policies. The government should establish policies that promote expansion of gas supply, reliability, and capacity, while fostering energy conservation. At the same time, government should not reverse past trends in deregulation.

Supply. Existing and planned environmental rules have a significant impact on gas supplies, thus price. Some of the largest undiscovered domestic natural gas are in areas that are currently off-limits to drilling due to environmental concerns regarding land use. Given development of more environmental friendly exploration and drilling technologies, Congress needs to reconsider existing land-use restrictions – especially those effecting on-shore areas in the lower 48 states, as well as in Alaska, and offshore areas currently off-limits to exploration and production.

Secondly, while the domestic natural gas resource base is large, extraction and recovery techniques can be made even more efficient through the funding of research and development

---

[2] Kenneth W. Costello and Daniel J. Duann, "Turning up the Heat in the Natural Gas Industry," Regulation,Vol. 19, No. 1, 1996, http://www.cato.org/pubs/regulation/reg19n1c.html.
[3] Ibid.
[4] Glenn R. Schleede, Energy Market & Policy Analysis, Inc., Fact Sheet, "High Monthly Natural Gas Bills and Their Economic Impact," February 5, 2001.
[5] Ibid.

(R&D) programs.[6] As such, government "cost sharing" initiatives in support of industry R&D efforts need to increase. Adequately funded R&D programs would facilitate exploitation of natural gas to its full potential. Examples include production from deep offshore deposits, frontier regions, and untapped coal-bed methane.

Capacity. Environmental land-use restrictions are also hindering expansion of the natural gas pipeline interstate system. As a result, gas demand at times may outpace pipeline capacity.[7] The costs of producing the gas may pale in comparison to the costs of gas transmission and distribution if transportation systems remain inadequate.

Additionally, liquid natural gas (LNG) import options need to be addressed. Among the policy options are the fast-tracking regulatory approval process to refurbish and expand existing LNG facilities as well as construction of new LNG shipping vessels.[8]

Reliability. Finally, the government must ensure that during economic expansions, supply disruptions are minimized. Steadily rising prices and/or price surges could create inflationary pressures on the economy and weaken our national security posture. The government should impose mandatory strategic storage levels to offset price spikes as well as to ensure reliable supplies.

CONCLUSION

The idea that natural gas is a commodity like any other non-fuel commodity is a relatively new concept. But as suppliers and customers have become more comfortable with this notion, there has emerged a reduced need for government intervention as a method of managing price risks. In lieu of government controls, spot and futures markets have emerged to provide both energy customers and suppliers with instruments for managing both price and risk. However, given the growing significance of natural gas, mounting public pressure to keep gas prices low and perceptions that natural gas is a strategic commodity, it may become increasingly tempting for the government to regulate the industry as it once did two decades ago.

Up to this point, gas price hikes are just beginning to flow to end users, and the full impact of last winter's higher prices is yet to be realized. As the end of next year's winter season approaches, and gas bills covering that period arrive, the intensity of public concern will again become evident, spurring new rounds of public debates and demands to lower natural gas prices. We must be cautious in responding to public concerns, however, by interfering with market forces. Instead, the government should intervene in ways that promote both consumer and industry interests over the long term. Its role is not one of price fixing, but rather of intervening in the areas where government intervention may be justified, such as ensuring that there are adequate strategic storage levels, distribution systems, and government funded R&D where this can make a difference in meeting energy needs.

---

[6] American Gas Association, Natural Gas Research and Development, December 29, 1998, http://aga.org/PublicInfo/NaturalGasBackground/ResearchandDevelopment/1143.html.

[7] U.S. Department of Energy, Energy Information Administration, Natural Gas 1998: Issues and Trends, pp. 109-125.

[8] American Gas Association, "Fueling the Future: Natural Gas & New Technology for a Cleaner 21st Century, The Supply Challenge," http://www.fuelingthefuture.org/Contents/MeetingtheChallenge.asp

OVERALL CONCLUSION

The U.S. energy industry is diverse, robust, fiercely competitive and technologically advanced. Its vibrancy and success are directly linked to our economic prosperity and hence our national security. Certainly, the world does not face an energy scarcity problem. The challenge for the U.S. in the future will be managing our production, transportation and distribution infrastructure. Externalities will play an increasing role in the future direction of this industry. We have a comparative advantage in several energy sectors (coal, natural gas, renewables and nuclear). Expanding environmental regulations could have an immense impact on those areas. Sound policy is imperative if we are to maintain our economic prosperity and standard of living. Technology will also play an increasing role in determining our future energy supplies. Environmental abatement, increased efficiencies and improved exploration and production are just a few areas in which technology has played key roles.

The three short essays were included to more fully analyze those areas we believe most urgently affect U.S. energy stability. One probed the dilemma posed for the coal industry, which is a major source of pollution but also the major source of electricity. If environmental standards are raised and breakthroughs do not occur in clean coal technology, reduction in coal use to meet environmental concerns would lead to greatly increased dependence on foreign energy sources, with attendant national security implications. The second essay explored the U.S. electricity sector and deregulation. Electricity deregulation will alter how the country produces, distributes and uses this vital resource. Lastly, the essay on natural gas focuses attention on the energy source that is experiencing the most rapid growth. All three topics contain strategically important implications for the U.S.

Secretary Abraham in a recent speech to the U.S. Chamber of Commerce stated, "The country is in the midst of an energy crisis with no short term solutions." Unlike previous energy crises, this one has been largely self-generated by our inattention to trends, lack of leadership and mismanagement. Our observation is that in a democracy like ours, it may take a watershed event like California blackouts to focus the public's attention to adequately address these issues.

One last parting thought: the Stone Age did not end because we ran out of stones. Horse carriages did not end because we ran out of horses. Further, we did not put a man on the moon because we all want to live there. The ingenuity of man leads him always to seek and develop a better mousetrap. Sometimes he is driven by money, sometimes by passion and sometimes by necessity. For these reasons, we have no doubt that the supply of energy will remain plentiful. The challenge for the future will be to develop and manage resources in a way that achieves an acceptable balance between the often competing demands of environmental protection and economic growth.

ENDNOTES

[1] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1999, "Energy in the United States: A Brief History and Current Trends," http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec1.pdf

[2] Derived from BP Amoco Alive, Statistical Review of World Energy June 2000, London, UK.

[3] U.S. Department of Energy, Energy Information Agency, "Energy Price Impacts on the U.S. Economy," http://www.eia.doe.gov/oiaf/economy/energy_price.html. Due to sharply higher energy prices since 1999, this estimate is probably conservative for 2000 or 2001.

[4] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1999, "Energy in the United States: A Brief History and Current Trends," Table 1.6, http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec1.pdf

[5] U.S. Department of Energy, Energy Information Administration, Petroleum: An Energy Profile 1999, Chapter 2 "Petroleum Products," http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/petroleum_profile_1999/profile99v8.pdf

[6] BP Amoco Alive, Statistical Review of World Energy June 2000, London, UK, p. 8.
[7] BP Amoco Alive, Statistical Review of World Energy June 2000, London, UK, p. 5.
[8] Exxon Corporation, The Upstream, a Guide to Petroleum Exploration and Production, 1982, p. 5.
[9] Alex Taylor III, "Oil Forever," Fortune, Vol. 140, Iss. 10, 22 November 1999, p. 193.
[10] U.S. Department of Energy, Energy Information Administration, Historical Petroleum Data, "Refinery Capacity and Utilization, 1949-1999," http://www.eia.doe.gov/pub/energy.overview/aer1999/txt/aer0509.txt
[11] U.S. Department of Energy, Energy Information Administration, http://www.eia.doe.gov/oiaf/forecasting.html and http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_supply_monthly/psm_historical.html
[12] Des Clifford , "World Coal," The Mining Journal LTD., September 2000.
[13] William A. Bruno, "Strategic Considerations for U.S. Coal Producers," CONSOL Energy, Inc., Brief to ICAF Energy Industry Study Seminar, 1 March 2001.
[14] U.S. Department of Energy, Energy Information Administration, Richard Bonskowski, "The U.S. Coal Industry in the 1990's: Low Prices and Record Production," September 1999, http://www.eia.doe.gov/cneaf/coal/special.coalfeat.htm#intro
[15] U.S. Department of Energy, Energy Information Administration, U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 1999 Annual Report (Table G1), http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/current/pdf/appg.pdf
[16] American Gas Association, "Fueling the Future: Natural Gas and New Technology for a Cleaner 21st Century," http://www.fuelingthefuture.org/contents/executivesummary.asp
[17]U.S. Department of Energy, Energy Information Administration, International Energy Outlook 2001, "Natural Gas," http://www.eia.doe.gov/oiaf/ieo/nat_gas.html
[18]Congressional Research Service, Joseph P. Riva, Jr., "The Domestic Natural Gas Status," June 1995, http://www.cnie.org/nle/eng-67.html
[19] U.S. Department of Energy, Energy Information Administration, "Natural Gas 1998: Issues and Trends, Foreign Trade – Canada", http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/chapter1.pdf
[20] U.S. Department of Energy, Energy Information Administration, "Figure 8.1 Nuclear Power Plant Operations," http://www.eia.doe.gov/pub/pdf/multi.fuel/mer/sec8_2.pdf
[21] Marvin S. Fertel, Nuclear Energy Institute, Brief to ICAF Energy Industry Study Seminar, 15 March 2001.
[22] Ibid.
[23] Nuclear Energy Institute, "Nuclear Energy Industry Status: Recent Events and Major Trends," January 2001, pp. 11-16.
[24] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1999, "Energy in the United States: A Brief History and Current Trends," http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec1.pdf
[25] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1999, "Energy in the United States: A Brief History and Current Trends," http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec1.pdf
[26] Nuclear Energy Institute, "Public Policy Issues – License Renewal," http://www.nei.org/doc.asp?catnum=4&catid=126
[27] Nuclear Energy Institute, "The Outlook for Nuclear Energy In a Competitive Electricity Business", Jan 2001, p. 2.
[28] U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1999, "Energy in the United States: A Brief History and Current Trends," http://www.eia.doe.gov/pub/pdf/multi.fuel/aer1999/sec1.pdf
[29] United States Department of Energy, Powering the New Economy: Energy Accomplishments, Investments, Challenges, 27 September 2000, p. 28.
[30] Ibid.
[31] Spencer Abraham, Secretary of Energy, Speech to the U.S. Chamber of Commerce, 12 April 2001.
[32] U.S. Department of Energy, Energy Information Administration, International Energy Outlook 2001, "World Oil Markets," http://www.eia.doe.gov/oiaf/ieo/oil.html
[33] Ibid.
[34] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2001 With Projections to 2020, December 22, 2000, http://www.eia.doe.gov/oiaf/aeo/index.html
[35] Ibid.
[36] U.S. Department of Energy, Energy Information Agency, http://www.eia.doe.gov/oiaf/forecasting.html
[37] Senator Pete Domenici, Speech on the Senate floor, Congressional Record, 6 October 2000.